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(54) Abstract Title
**Vehicle safety belt tensioning means**

(57) A safety belt apparatus for a motor vehicle comprises a seat belt 12 and a tensioner which can be mounted to the vehicle in a region of a free belt section and which cooperates with the belt to alter the effective length of the belt, and where the path of the belt can be altered by the tensioner. The tensioner comprises at least two guide reels 71, 72, 73 around which the belt is guided and which can be moved relative to each other to alter the course of the belt, and a control device with which the relative position of the guide reels is adjustable at any time in the normal operation of the vehicle in accordance with a pre-set contact pressure of the safety belt at an occupant. Also disclosed is a tensioning means comprising a series of clamping wedges (figure 1).

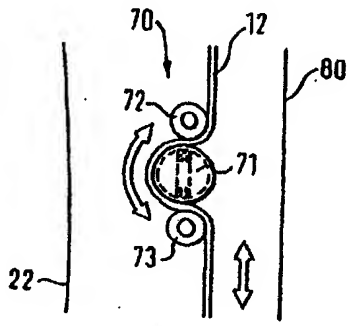


FIG. 4

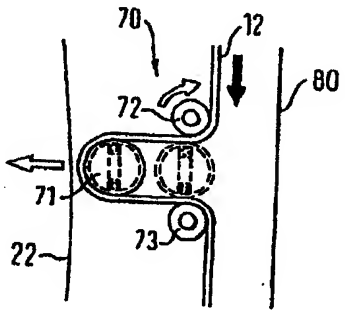


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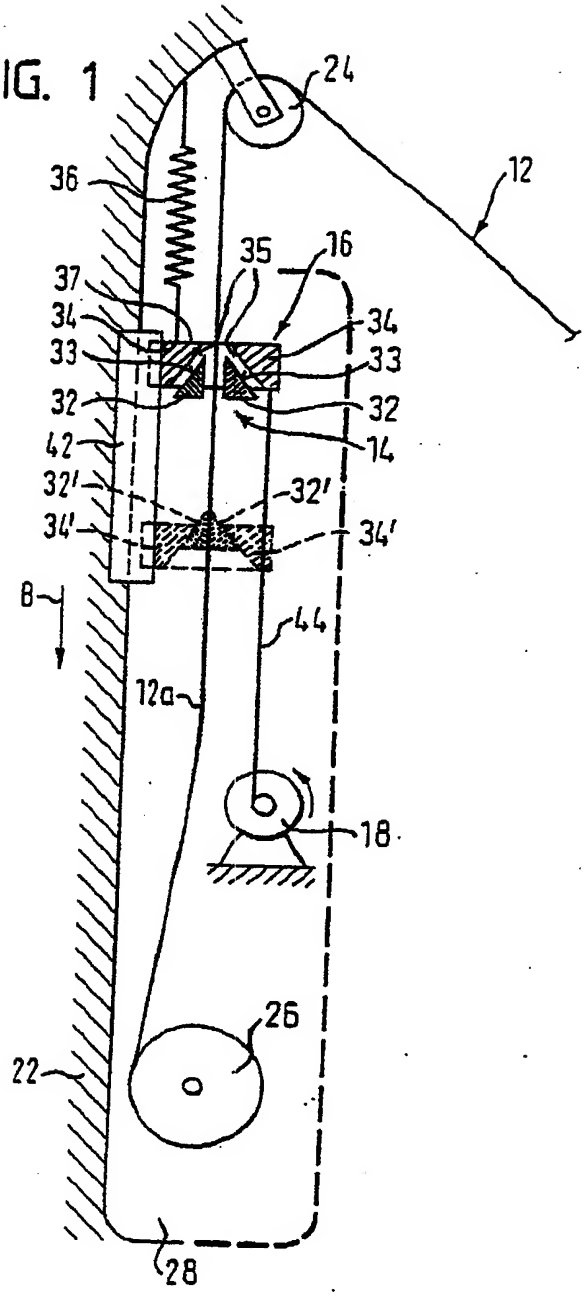
FIG. 1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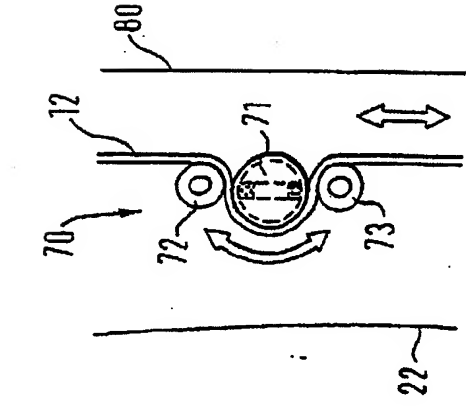
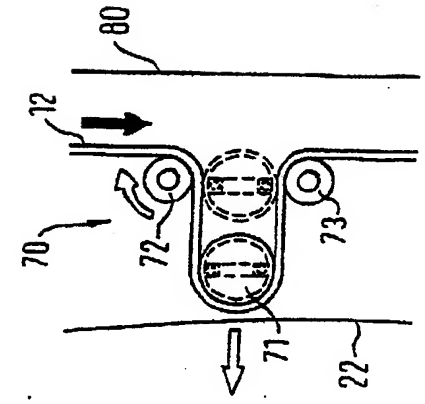



FIG. 4



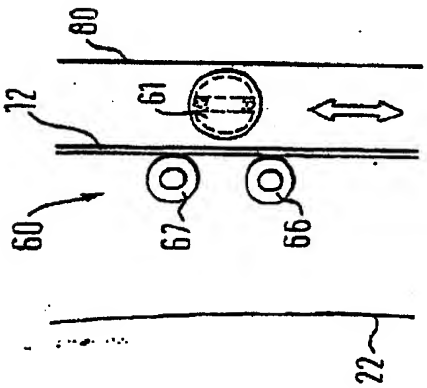
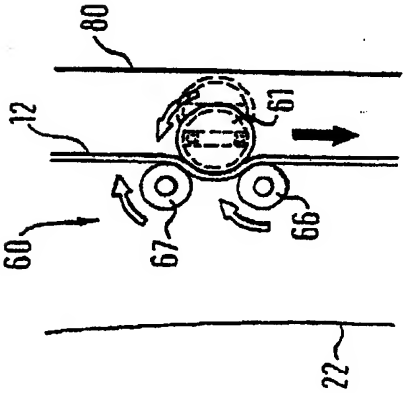




FIG. 3



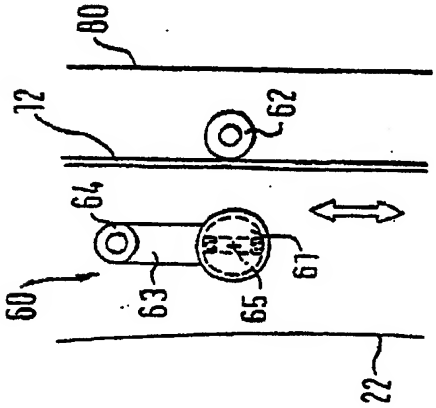
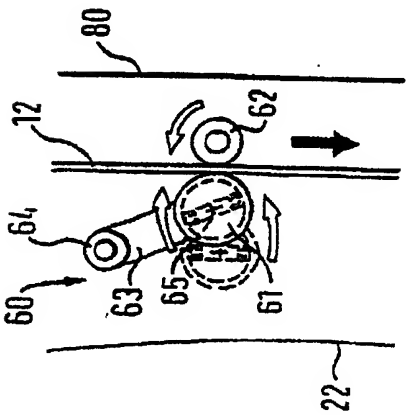




FIG. 2



# Safety belt apparatus

The invention relates to a safety belt apparatus for motor vehicles comprising a safety belt and a belt tensioner.

Belt tensioners ensure that in the event of an accident the safety belt contacts the body of the respective occupant tightly and that the protective effect of the safety belt is thus optimum.

It is desirable to provide a safety belt apparatus of the kind initially named in which a reliable tensioning of the safety belt is achieved, in particular a tensioning as independent as possible of other means of the safety belt apparatus.

The present invention provides a safety belt apparatus for motor vehicles comprising a safety belt and a belt tensioner which can be mounted to the vehicle in the region of a free belt section and which cooperates with the safety belt in the region of the free belt section to alter the effective length of the safety belt, wherein the path of the safety belt can be altered by the belt tensioner, and the belt tensioner comprises at least two guide reels around which the safety belt is guided and which can be moved relative to one another to alter the course of the safety belt, and wherein a control device is provided with which the relative position of the guide reels is adjustable at any time in the normal operation of the vehicle in accordance with a pre-set contact pressure of the safety belt at a vehicle occupant.

Since the belt tensioner in accordance with the invention is attachable in the region of a free belt section and cooperates with the safety belt in the region of this free belt section, the belt tensioning can take place independently of other means of the safety belt apparatus. The non-dependence on other means has the advantage that the belt tensioner in

accordance with the invention can be subsequently integrated in existing safety belt apparatuses and can be made available as a retro-fitting kit. The length effective at the vehicle occupant can in particular be altered independently of a belt tensioner.

A further advantage of the invention lies in the fact that the effective length of the safety belt, that is the section of the safety belt between the belt tensioner and the buckle which restrains the vehicle occupant in the event of an accident, is not only reduced, but can optionally also be extended in a defined manner. The contact pressure of the safety belt at the vehicle occupant can thus be set directly. A control device can be provided for this purpose with which the effective length of the safety belt can be set in the normal operation of the vehicle in accordance with a pre-set contact pressure, which can, for example, be selected by the vehicle occupant himself. Appropriate measuring devices can be provided to realize such a "comfort function", with which a value corresponding to the contact pressure, e.g. the belt tension or a force applied to a further component via the belt, can be measured.

Moreover, an optimum protection against a so-called "second impact", in which the vehicle is exposed to a second impact subsequent to a first impact, can be provided with the invention. Such a second impact occurs, for example, when the vehicle drives through an obstacle (first impact) and is brought to a halt in a subsequent second impact. The belt tensioner can furthermore be deliberately used, independently of other means of the safety belt apparatus, for the purpose of positioning the vehicle occupant prior to the second impact such that the safety belt can again develop its optimum protective effect. Moreover, the belt tensioning in accordance

with the invention can be deliberately designed such that existing occupant restraining systems of the vehicle are reinforced or complemented in their protective effect in particular with respect to the second impact protection.

A preferred embodiment proposes that the belt tensioner comprise a clamping unit which is controllable starting from a rest position into clamping engagement with the safety belt.

The cooperation between the belt tensioner and the safety belt is effected by a clamping of the respective belt section such that the clamped belt section can be moved such that the effective length of the safety belt is altered in the desired manner, i.e. the safety belt contacts the body of the vehicle occupant in a more or less tight manner.

In a further embodiment, it is proposed to alter the path of the safety belt by the belt tensioner.

The path of the safety belt, and thus the effective length of the safety belt, can be directly set, for example, by the forming of a loop which can be changed in size.

In accordance with a further preferred embodiment, it is provided that the belt tensioner can be moved along the belt section.

In this way, an at least substantially linear movement of the belt tensioner can be utilized in order to steer a clamping unit of the belt tensioner into clamping engagement with the safety belt. The non-dependence of the

apparatus in accordance with the invention on other vehicle means is given here by the belt tensioner utilizing its own movability.

In a further preferred practical embodiment of the invention, the belt tensioner has a control unit which can be driven directly to make a movement along the belt section and via which the clamping unit can be steered into clamping engagement with the safety belt. It is preferably provided that the clamping unit can be moved together with the control unit, with a lag with respect thereto, along the belt section. The clamping unit can be coupled to the control unit such that the lag of the clamping unit is the result of inertia. The lag is utilized to steer the clamping unit into clamping engagement with the safety belt. After activation of the belt tensioner drive, the control unit is thus first set in motion and this motion is converted into the clamping movement of the clamping unit. The clamping unit is hereby brought into clamping engagement with the safety belt. The clamping unit and the clamped safety belt are subsequently moved on together with the control unit, whereby the desired belt tensioning is achieved.

The clamping unit can comprise at least one clamping member which is provided with a control surface at its side remote from the safety belt which can be loaded by a control section of the control unit. It is preferred if the clamping member is formed as a clamping wedge and the control section as a correspondingly shaped cooperating wedge.

The clamping unit preferably comprises at least two oppositely disposed clamping members which can be moved toward one another by movement of the belt tensioner. The clamping members serve as clamping jaws

between which the safety belt can be clamped by a movement of the belt tensioner. The clamping members can be formed as identically designed clamping wedges which are arranged symmetrically with respect to the safety belt and which are each provided at their side remote from the safety belt with an oblique surface extending at an angle with respect to the direction of movement of the control unit.

To realize a clamping function, the belt tensioner can, in accordance with a further embodiment, comprise at least two clamping reels which can be moved relative to one another in order to form a clamping gap for the safety belt, with at least one clamping reel being provided with a rotary drive.

To alter the effective length of the safety belt, the safety belt is first clamped between the two clamping reels, which can be moved accordingly for this purpose, with the clamping reel provided with the rotary drive being subsequently set into rotation in order to transport the safety belt through the clamping gap in this way. The direction, the degree and the speed of the alteration in length can be deliberately set with high precision in this manner.

In accordance with a further embodiment, the belt tensioner can comprise at least two guide reels around which the safety belt is guided and which can be moved relative to one another to alter the path of the safety belt in order to adjust the effective length of the safety belt by altering its path.

The path of the safety belt guided round the guide reels and guided in a compulsory manner in this way is pre-set in any relative position.

The belt tensioner is preferably arranged in accordance with the invention in a region between a belt winding reel and a belt deflector or a guide device for the belt. In applications in which no belt deflector and no belt guide is provided, the belt tensioner is preferably arranged in the region between a belt winding reel and the level of the shoulder of the respective occupant.

It is particularly preferred if the belt tensioner is mounted in the region of the B or C pillar of the vehicle, in particular within the B or C pillar. It is alternatively also possible to arrange the belt tensioner in the region of the rear shelf, in particular beneath the rear shelf.

It is furthermore preferably provided that the belt tensioner can be moved out of a rest position against the restoring force of a restoring means, in particular of a return spring.

A clamping of the safety belt or a previously set path of the safety belt corresponding to a certain effective length of the safety belt can be cancelled or altered again in a simple manner in this way. A reversible system is created in this way.

It is further preferably provided for the belt tensioner to comprise a separate drive, in particular in the form of an electric motor.

The belt tensioner can in this way be designed to ideally achieve the protective function intended for it independently of other means of the vehicle.

The invention moreover relates to a belt tensioner for motor vehicles which can be mounted to the vehicle in the region of a free belt section and which cooperates with the safety belt in the region of the free belt section in order to alter the effective length thereof.

The belt tensioner is preferably formed as a retro-fitting kit which can be subsequently integrated in a safety belt apparatus of the vehicle. The belt tensioner can be designed such that constructive circumstances of the vehicle are advantageously used.

Preferred embodiments of the invention are also given in the dependent claims, the description and the drawing.

The invention is described by way of example with reference to the drawing in the following. There are shown:

Fig. 1 an embodiment of safety belt apparatus in accordance with the invention in a schematic side view; and

Figs. 2 – 4 further embodiments of a safety belt apparatus in accordance with the drawing.

A side panel 22 of a motor vehicle in the region of the B pillar 28 is shown schematically in Fig. 1. A safety belt apparatus, for example for the driver of the motor vehicle, comprises a safety belt 12, a deflector 24 and a winding reel 26.

A belt tensioner is arranged between the deflector 24 and the winding reel 26 and comprises a clamping unit 14, a control unit 16 and a drive 18. The belt tensioner is shown by solid lines in an upper rest position in which the safety belt 12 can be moved without obstacle between two clamping wedges 32 of the clamping unit 14 serving as clamping jaws which are arranged spaced from one another in the rest position.

The control unit 16 comprises two control sections 34 – whose cooperation with the clamping members 32 of the clamping unit 14 is described in more detail in the following – and is coupled to a guide device 42 at the side panel 22 of the vehicle formed, for example, as a guide strip, guide rod or guide rail. The guide means 42 can have any form in principle. The control unit 16 can be moved downwardly in the direction of the arrow B by means of the drive 18, with the control unit 16 being guided in linear manner by the guide device 42 and thus moved parallel along the vehicle side panel 22 along the belt section 12a extending between the deflector 24 and the winding reel 26.

In the embodiment shown, the drive 18 comprises a winding mechanism driven by an electric motor for a drive means 44 in the form of a rope which is fastened to a housing 37 of the control unit 16 surrounding the clamping unit 14 and the safety belt 12. The drive 18 in question is thus an electrical linear drive for the belt tensioner which allows an electrical linear tensioning of the safety belt 12.

A motorized gear can, for example, alternatively be provided as the electrical linear drive and can cooperate with a rack mounted to the housing 37 of the control unit 16.

The movement of the control unit 16 from the upper rest position in the direction of the arrow B is made against the restoring force of a return spring 36 whose one end is fastened to the control unit 16 or its housing 37 and whose other end is fastened to the side panel 22 or the transition region between the side panel 22 and the vehicle roof.

The clamping jaws 32 of the clamping unit 14 are movably supported at the control unit 16 or in the housing 37 such that they can be moved toward one another in order to be brought into clamping engagement with the safety belt 12 by this clamping movement. To ensure a spacing between the clamping surfaces of the clamping wedge 32 sufficient for an unhindered pulling out and rolling up of the safety belt 12, the clamping unit 14 can be provided with spring means which press apart the clamping wedges 32 with a pre-set bias force.

The clamping members 32 are furthermore movably supported in the control unit 16 and relative to the direction of movement B thereof such that a movement of the control 16 from the rest position effected by the drive 18 is not initially transmitted to the clamping members 32. The clamping members 32 rather initially remain in the starting position due to their inertia until they are directly loaded by the control sections 34 of the downwardly moved control unit 16.

Spring means can be provided which act in the direction of movement B between the control sections 34 and the clamping members 32 and which hold the clamping unit 14 and the control unit 16 spaced in the rest position.

The clamping members 32, which have the same construction and which are arranged symmetrically with respect to the plane defined by the belt section 12a, are each provided with an oblique surface 33 at their side remote from the belt. The oblique surface 33 extends at an inclination to the direction of movement B of the control unit 16 and serves as a control surface. The control sections 34 of the control unit 16, whose spacing is constant perpendicular to the direction of movement B, are formed as cooperating wedges for the clamping wedges 32 and each have a correspondingly inclined control surface 35. The clamping members 32 are consequently moved toward one another into clamping engagement with the belt section 12a by the downward movement of the control sections 34. The linear movement of the control unit 16 is thus converted into a clamping movement of the clamping unit 14 perpendicular thereto.

As soon as the clamping surfaces of the clamping organs 32 are pressed against one another with the safety belt 12 between them, they are moved further downwardly together with the control unit 16. In the figure, the end position of the clamping members 32' and the control sections 34' is represented by broken lines.

The safety belt 12 clamped in this way is taken along in a downward direction via the downwardly moving clamping members 32, which are pressed against one another, whereby the desired belt tensioning is achieved.

In accordance with the invention, the clamping force of the clamping unit 14 becomes active with a lag with respect to the movement of the control

unit 16. This lag is determined by the time which passes until the clamping members 32 are directly loaded by the control sections 34, moved toward one another and pressed against one another with a sufficiently large force.

As an alternative to the apparatus explained, it is also possible in accordance with the invention to arrange the control unit 16 and the clamping unit 14 in the rest position such that the control surfaces 33, 35 contact one another. In this case, the clamping movement of the clamping members 32 extending perpendicularly to the direction of movement B is initiated immediately after the activation of the drive 18.

The time during which the drive 18 is active and holds the belt tensioner in the active position with the safety belt 12 clamped and thus tensioned between the clamping members 32 can be deliberately set independently of other means of the vehicle, in particular of the belt reel 26, such that the respective vehicle occupant is reliably restrained in the vehicle seat even in the case of a further impact (second impact) following a first impact triggering the drive 18.

As soon as the force driving the control unit 16 downwardly is no longer active after the de-activation of the drive 18 or the uncoupling from the drive 18, the control unit 16, and with it the clamping unit 14, is again returned to the upper rest position by the restoration means 36, with the clamping members 32 coming out of engagement with the safety belt 12, which can thus be pulled out again without hindrance so that the vehicle occupant can undo the safety belt 12.

The belt tensioner in question is thus a reversible system whose original starting state can be restored after a belt tensioning has been carried out.

The lag with which the belt tensioning is carried out after the triggering of the drive 18 can be deliberately set by the speed with which the drive 18 becomes active and by the speed with which the control unit 16 is moved downwardly. Moreover, the lag can be influenced by a corresponding selection of the spacing present in the direction of movement B between the control sections 34 and the clamping members 32 and of the spacing present perpendicular to the direction of movement B between the clamping surfaces of the clamping members 32 facing one another.

In Figs. 2 – 4, the upper representation corresponds in each case to normal operation in which the safety belt 12 can be pulled from a belt reel (not shown) and wound up on it unhindered by the belt tensioner 60, 70, whereas the lower representation shows in each case the state with the active belt tensioner 60, 70.

In the embodiment in accordance with Fig. 2, the belt tensioner 60 comprises two clamping reels 61, 62. The one clamping reel 61 is mounted to the one end of a pivot arm or rocker arm 63 which is freely pivotable around an axis 64 at its other end. The one clamping reel 61 is associated with a rotary drive (not shown), for example in the form of an electric motor, with which the reel 61 can be set into rotation around an axis 65. The other clamping reel 62 is freely rotatable.

The starting position of the belt tensioner 60 is shown in the upper illustration of Fig. 2 in which the safety belt 12 can be moved freely two

and fro between the clamping reels 61, 62, as is indicated by the double arrow. The pulling out and winding up of the safety belt 12 from or with the reel (not shown) is not affected by the belt tensioner 60 in this starting position.

The belt tensioner 60 in accordance with the invention is designed such that when the rotary drive is activated and the rotation of the clamping reel 61 started, the pivot arm 63 is deflected in the direction of the other clamping reel 62, as is shown in the lower illustration of Fig. 2, due to the moment generated thereby. The safety belt 12 is thereby clamped between the two clamping reels 61, 62 and transported by the clamping gap formed by the reels 61, 62 in accordance with the direction of rotation of the drive reel 61.

In the embodiment in accordance with Fig. 3, the clamping reel 61 provided with a rotary drive can be moved in a direction perpendicular to the path of the safety belt 12. The reel 61 can thereby be moved out of the starting position in accordance with the upper illustration in Fig. 3 against two freely rotatably clamping reels 66, 67 spaced along the safety belt 12. Two clamping gaps for the safety belt 12 are formed in this way through which the safety belt 12 is transported as soon as the drive reel 61 is set into rotation, as is indicated by the arrows in the lower illustration of Fig. 3.

In the embodiment in accordance with Fig. 4, an alteration is made to the effective length of the safety belt 12 by its path being altered in the region of the belt tensioner 70. For this purpose, three freely rotatable guide reels

71, 72 73 are provided in this embodiment around which the safety belt 12 is wound and which form a compulsory guide for the safety belt 12.

The guide reel 71 is movable relative to the two stationary guide reels 72, 73 perpendicular to the actual longitudinal extent of the safety belt 12. A loop of variable size can be formed in the safety belt 12 by adjusting the guide reel 71 so that the effective length of the safety belt 12 can be set as appropriate by setting a certain relative position of the guide reels 71, 72, 73. The belt tensioning indicated by the dark arrow in the lower illustration of Fig. 4 is carried out by the guide reel 71 in Fig. 4 being moved to the left with the belt reel (not shown) locked.

Furthermore, a so-called comfort function can be advantageously realized with the belt tensioner 70 in accordance with Fig. 4 in the normal operation of the vehicle. For this purpose, the position of the guide reel 71 is set according to a pre-set contact pressure of the safety belt 12 at the respective vehicle occupant, with this pressure being determined by a suitable sensor system and being transmitted to a control device formed to control the guide reel 71. The embodiment in accordance with Fig. 4 can, however, also be realized without a comfort function.

The belt tensioner in accordance with the invention is preferably provided in the form of a compact unit and accommodated within a, for example, box-shaped housing adapted to the constructive circumstances of the respective vehicle. The housing 80 mounted in the region of a side panel 22 of the vehicle is indicated in Figs. 2 – 4.

The apparatus of the belt tensioner is not restricted to the B pillar and can also be made, for example, in the region of the C pillar of the vehicle. Alternatively, the belt tensioner could also be arranged in the region of the rear shelf.

An important advantage of the belt tensioner in accordance with the invention lies in the fact that it can be subsequently integrated into the vehicle, for example in its B or C pillar 28 or at another position and that thus existing safety belt apparatuses can be retro-fitted.

-.-.-

Reference numeral list

| | |
|---|---|
| 12 | safety belt |
| 12a | belt section |
| 14 | clamping unit |
| 16 | control unit |
| 18 | drive |
| 22 | side panel of the vehicle |
| 24 | belt deflector |
| 26 | belt reel |
| 28 | B pillar |
| 32, 32' | clamping member |
| 33 | control surface |
| 34, 34' | control section |
| 35 | control surface |
| 36 | restoring device |
| 37 | housing |
| 42 | guide device |
| 44 | drive means |
| 60 | belt tensioner |
| 61 | clamping reel |
| 62 | clamping reel |
| 63 | arm |
| 64 | pivot axis |
| 65 | axis of rotation |
| 66 | clamping reel |
| 67 | clamping reel |
| 70 | belt tensioner |
| 71 | guide reel |
| 72 | guide reel |
| 73 | guide reel |
| 80 | housing |
| B | direction of movement |

CLAIMS:

1. A safety belt apparatus for motor vehicles comprising a safety belt and a belt tensioner which can be mounted to the vehicle in the region of a free belt section and which cooperates with the safety belt in the region of the free belt section to alter the effective length of the safety belt, wherein the path of the safety belt can be altered by the belt tensioner, and the belt tensioner comprises at least two guide reels around which the safety belt is guided and which can be moved relative to one another to alter the course of the safety belt, and wherein a control device is provided with which the relative position of the guide reels is adjustable at any time in the normal operation of the vehicle in accordance with a pre-set contact pressure of the safety belt at a vehicle occupant.

2. A safety belt apparatus for motor vehicles comprising a safety belt (12) and a belt tensioner (14, 16, 18; 60; 70) which can be mounted to the vehicle in the region of a free belt section (12a) and which cooperates with the safety belt (12) in the region of the free belt section (12a) to alter the effective length of the safety belt (12).

3. An apparatus in accordance with claim 2, characterized in that the belt tensioner (14, 16, 18; 60) comprises a clamping unit (14; 61, 62, 63; 61, 66, 67) which can be steered into clamping engagement with the safety belt (12) starting from a rest position.

4. An apparatus in accordance with claim 2 or claim 3, characterized in that the path of the safety belt (12) can be altered by the belt tensioner (70).

5. An apparatus in accordance with at least one of the preceding claims 2 to 4, characterized in that the belt tensioner (14, 16, 18) is movable along the belt section (12a) and is in particular guided in the region of a side panel (22) of the vehicle.

6. An apparatus in accordance with claim 5, characterized in that the belt tensioner has a control unit (16) directly drivable to make a movement along the belt section (12a), via which a clamping unit (14) of the belt tensioner is steerable into clamping engagement with the safety belt (12).

7. An arrangement in accordance with claim 6, characterized in that the clamping unit (14) is movable along the belt section (12a) together with a control unit (16) with a lag with respect thereto, with in particular the lag being caused by the inertia of the clamping unit (14).

8. An arrangement in accordance with claim 6 or claim 7, characterized in that the clamping unit (14) has at least one clamping means (32, 32') which is provided on its side remote from the safety belt (12) with a control surface (33) which is loadable by a control section (34, 34') of the control unit (16).

9. An arrangement in accordance with claim 8, characterized in that an oblique surface extending with an incline with respect of the direction of movement (B) of the control unit (16) is provided as the control surface (33).

10. An arrangement in accordance with claim 8 or claim 9, characterized in that the clamping means (32, 32') is formed as a clamping wedge, with preferably a control section (34, 34') of the control unit (16) being formed as the counter-wedge for the clamping means (32, 32').

11. An arrangement in accordance with at least one of claims 6 to 10, characterized in that the clamping unit (14) has at least two clamping means (32, 32') which are opposite one another and which can be moved toward one another by moving the belt tensioner.

12. An arrangement in accordance with at least one of the preceding claims 2 to 11, characterized in that the belt tensioner (14, 16, 18) can be moved out of the rest

position against the restoring force of restoring device (36), in particular of a return spring.

13. An arrangement in accordance with at least one of claims 2 to 4, characterized in that the belt tensioner (60) comprises at least two clamping reels (61, 62; 61, 66, 67) which can be moved relative to one another to form a clamping gap for the safety belt (12), with at least one clamping reel (61) being provided with a rotary drive.

14. An arrangement in accordance with claim 13, characterized in that the drivable clamping reel (61) is mounted onto a freely pivotable arm (63) with an axis of rotation (65) offset parallel to its pivot axis (64).

15. An arrangement in accordance with claim 4, characterised in that the belt tensioner (70) comprises at least two guide reels (71, 72, 73) around which the safety belt (12) is guided and which can be moved relative to one another to alter the course of the safety belt (12).

16. An arrangement in accordance with claim 15, characterized in that a control device is provided with which the relative position of the guide reels (71, 72, 73) is adjustable at any time in the normal operation of the vehicle in accordance with a pre-set contact pressure of the safety belt (12) at a vehicle occupant.

17. An arrangement in accordance with at least one of the preceding claims 2 to 16, characterized in that the belt tensioner (14, 16, 18; 60; 70) can be mounted in the region of the B or C pillar (28) of the vehicle, in particular within the B or C pillar (28).

18. A belt tensioner for motor vehicles which can be mounted to the vehicle in the region of a free belt section (12a) and which cooperates with the safety belt (12) in the region of the free belt section (12a) to alter the effective length thereof.

19. A belt tensioner in accordance with claim 18, characterized in that it is formed as a retro-fitting kit which can be subsequently integrated into a safety belt arrangement.

20. A belt tensioner in accordance with claim 18 or claim 19, characterized by the features relating to a belt tensioner of at least one of claims 2 to 16.